FRACTURE OF THE NECK OF THE HUMERUS WITH DISLOCATION OF THE UPPER FRAGMENT, WITH A REPORT OF THREE CASES TREATED BY OPERATION.[1]

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THE serious and rather rare combination of fracture of the humerus at the surgical neck or higher, with simultaneous displacement of the head from the glenoid cavity, has been known to surgeons since before the Christian era. Equally ancient is the device of securing the best possible union of the bone before making vigorous efforts to reduce the dislocation. (This paper does not include cases of fracture resulting from attempts to reduce old dislocations of the shoulder.)

The fracture may take place at the surgical neck or at any point above up to the anatomical neck. In ninety-six cases collected by McBurney and Dowd (ANNALS OF SURGERY, 1894, xix, 401), sixty-nine were at the surgical neck and twenty-seven at the anatomical. The fissure may be limited to the anatomical neck, but if it lies as high as that point there are usually other fissures splitting off the tuberosities. According to Poirier and Mauclaire (*Revue de Chirurgie,* 1892, 865), of 102 cases in which the fracture occurred at the surgical neck, in only two was comminution present, but in five others a second fissure existed at the anatomical neck. In my three cases, one was at the surgical neck, one at the anatomical, and the third was a fracture at the latter point, with comminution of the tuberosities.

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[1] Read before the New York State Association of Railway Surgeons, by invitation, November 16, 1899.

The head may lie displaced in any of the situations occupied in simple dislocations. When the fracture is at the anatomical neck the head is most frequently found in the axilla; but there are two cases on record in which it lay posteriorly beneath the spinous process of the scapula (Houzelot, quoted by Delpech, *Chirurgie clinique de Montpellier*, 1823, Vol. i, p. 233, and Brinton, quoted by Souchon, *Transactions of American Surgical Association*, 1897, p. 332,—a fracture involving the tuberosities also). According to Poirier and Mauclaire (*loc. cit.* p. 866), of 103 cases of fracture of the surgical neck the head of the bone lay in the subcoracoid position in eighty-six cases, intracoracoid in thirteen, subglenoid in three, and subspinous in one case. It will be noted that in these cases there is an unusual proportion of the infrequent displacements of the head, for in the simple dislocations of the shoulder axillary and intracoracoid displacements are not common. In my cases the simple fracture through the anatomical neck was accompanied with displacement of the head in the axilla, while in the other cases there was a subcoracoid dislocation.

The prognosis of this injury under the older conservative methods of treatment was not good, for the dislocation generally remained unreduced. If reduction is not accomplished, the disability may be less than when a simple dislocation of the shoulder has been left unreduced, especially if the upper fragment is small, and the lower fragment is so situated as to articulate well with the scapula. But even in such cases complete ankylosis may be produced by the misplaced callus thrown out around the bones, and, indeed, some sort of union between the ends with a consequent limitation of motion is the rule. Suppuration at the point of fracture is rare, and so also is necrosis of the upper fragment, no matter how small it may be. In exceptional cases a fair functional result may follow, the stiffness of the shoulder-joint being to some degree atoned for by the great mobility of the scapula. But in addition to stiffness of the joint, the displaced head presses upon the vessels, causing serious disturbance of the circulation (gangrene has been known to follow), and upon the nerves, producing great pain. The patients are generally eager to have an attempt made to relieve them, even when the function of the limb is not bad. The results of late operations done to correct the deformity and other consequences of this injury are unsatisfactory, and therefore it is essential to treat the cases properly in the beginning. This paper is limited to the consideration of cases treated immediately or within the first month after the injury.

The methods of treatment recommended are four,—reduction by manipulation, production of a false joint or nearthrosis, resection of the upper fragment (the head of the humerus), and open arthrotomy with reduction of the head. The ancient method of securing union of the fracture first, and then attempting reduction four to six weeks after the receipt of the injury, has given such poor results (three doubtful successes, all fractures of the surgical neck, in a series of ten cases) that it is now almost universally condemned. Even in 1884 (*France médicale*, 1884, p. 1613), Berger said that this method was not merely useless but dangerous, on account of the adhesions of vessels and nerves to the callus and new cicatricial tissue. We need not consider it at greater length.

(A) *Reduction by Manipulation.*—In every case the first and immediate duty of the surgeon is to make careful attempts to return the head of the humerus to the glenoid cavity by suitable manipulation. It was formerly taught to make forcible traction with the heel in the axilla; but this method is useless, because the head has been separated from the shaft of the humerus, and cannot be made to move by traction exerted upon the latter. Richet (*Mémoires de la Société de Chirurgie*, Paris, III, 1853, p. 445) emphasized the value of pressure upon the head with the fingers without traction, especially when the head lay in the axilla,—" méthode de refoulement." Stimson, in the first edition of his "Treatise on Fractures" (Philadelphia, 1882, p. 382), followed by Berger, recommends gentle traction, in hopes that periosteal connections may have been left which will allow of some control of the movements of the head in addition to the direct pressure. We would add the suggestion that in some cases gentle rotation might assist the traction, especially in cases with some impaction. Forcible efforts would only do harm, as they would separate the remaining connections between the fragments, and might pull on the capsule in some cases in such a manner as to close the rent through which the head had escaped. A possible exception might be made in the case of simple fracture of the anatomical neck with displacement, for in such a case, after opening the joint from above, the writer found that the close approximation of the upper end of the shaft to the glenoid cavity was the main obstacle to reduction of the head, and the latter was accomplished only by forcibly separating the two bones by traction upon the humerus and by crowding the fingers into the articular space. In cases of fracture at the anatomical neck, therefore, if gentle traction fails, forcible traction may be tried with the arm in abduction, while pressure is made on the head, in hopes that the cleft of the joint may be sufficiently widened to allow the head to return. An anæsthetic should always be administered, and undue violence must be avoided.

Thamhayn (" Dissertation," Halle, 1868, see *Schmidt's Jahrbuch*, 1868, cxl, p. 194) collected sixty-eight cases in which reduction was successful in twenty-two. McBurney (ANNALS OF SURGERY, 1896, xxiii, p. 502) collected eighty cases with thirty-six successes, the increased number probably being due to the more general use of anæsthetics and to the earlier diagnosis.

(B) *Production of a False or New Joint.*—It was held by some of the older surgeons that, if reduction were impossible, the best treatment would consist in beginning passive exercise at once, in order to preserve the motions of the part; in other words, trying to form a new joint between the fractured surfaces or between the lower fragment and the scapula. In 1843, Riberi treated a case by thus making a false joint at the seat of fracture, and this method is generally known by his name. It has proven especially useful when the humerus has been broken in attempts to reduce an old dislocation of the shoulder. A number of cases of simultaneous fracture and dislocation are also on record as having been so treated, but it cannot be said that the results are encouraging. The patient appears to have obtained somewhat more motion than if the case had been left to nature, and a decidedly better position of the arm than if the humerus had been allowed to consolidate at the point of fracture. But the joint was unsatisfactory in its movements, and the displaced head caused pain and disturbances of the circulation by its pressure. This method may then be laid aside with the ancient method except for cases in which circumstances render operative treatment impossible. If employed at all, the passive and active motions should be begun at the earliest possible moment after the injury.

(C) *Resection.*—As early as 1823, Delpech, in his *Chirurgie clinique de Montpellier* (Vol. i, p. 233), advised immediate removal of the displaced head in cases with fracture of the anatomical neck, for fear of necrosis. Morton in 1884 (*American Journal of the Medical Sciences*, lxxxvii, p. 173) appears to have been the first to attempt it in a recent case, although it had been removed in old irreducible dislocations before that date. Souchon (*loc. cit.*, pp. 322–332) quotes ten cases so treated (Tripier, Porter, Morton, Mauclaire two, Croft, Clutton, Monks, McGraw, and Brinton). Gerster reports (ANNALS OF SURGERY, 1898, xxvii, p. 660) a subglenoid displacement of the head, with fracture of the anatomical neck, treated by resection four weeks after the injury, followed by infection of the wound and death in five days. The following case of mine also belongs here.

CASE I.—*Comminuted Fracture of the Upper Extremity of the Humerus, with Subcoracoid Displacement of the Head; Resection; Recovery.*—E. H., twenty-nine years old, single, native of the United States, a truck driver by occupation, was admitted to my service at Bellevue Hospital March 9, 1899. He claims previous good health, and denies venereal disease, but uses alcohol to excess. Two days before admission he had a "fit" while at work and fell, striking on the left shoulder, and did not regain consciousness until some time afterwards. An examination of the shoulder under ether was made, and a large bony mass was found in the subcoracoid region, with great thickening of the upper end of the humerus—of which the mass seemed a part. The elbow could be brought to the side, and there was but little shortening. Crepitus near the upper end of the humerus could be recognized, but the exact situation of the fracture could not be determined because of the great swelling of the parts from effused blood. There was no deltoid flattening, and the injury was evidently neither a simple dislocation nor a fracture of the surgical neck of the humerus. The diagnosis was left open between fracture of the anatomical neck with displacement of the head, and comminuted fracture through the anatomical neck and tuberosities. March 12 the patient became very noisy and was transferred to the alcoholic ward. On recovery from the nervous symptoms, an X-ray picture was taken very kindly for me, by Dr. F. W. Gwyer, which clearly showed the glenoid cavity to be empty, and less distinctly indicated a fissure through the tuberosities, and the presence of the head of the bone beneath the coracoid process. The swelling had meanwhile subsided, so that the head of the bone could be distinctly felt in its abnormal position. It was evident that if nothing were done, the shoulder would become completely stiff and useless from the displaced head, and excess of new bone close up to the joint, and operation was accepted by the patient. The shoulder-joint was immovable and painful.

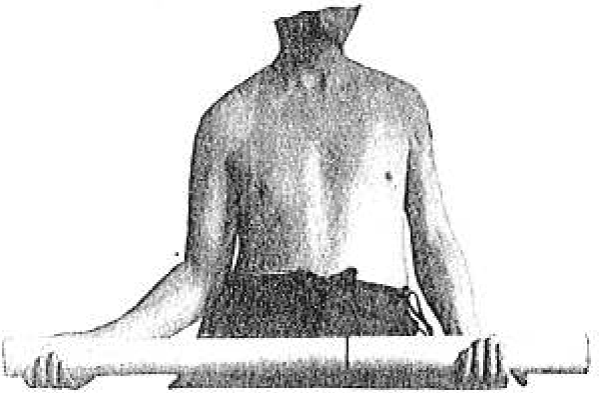

FIG. 1.—Showing scar of operation for fracture dislocation of humerus and loss of external rotation.

March 28.—Ether was administered, and an anterior incision made over the head of the bone along the margin of the deltoid. The head of the bone was found in the tissues below the coracoid process, having been separated from the shaft exactly along the anatomical neck, and lying with its fractured surface turned towards the broken end of the shaft, partly overlapping the latter. As there was danger of necrosis if this small fragment of bone, which lay entirely outside of the capsule, were separated from the vascular connections formed in the three weeks elapsed since the injury, and forced back into the glenoid cavity, no attempt at reduction was made. The head was easily removed from its loose bed. There was so much callus forming about the upper end of the humerus, the tuberosities being also detached, that a large part of the greater tuberosity was also removed, in order to improve the chances for free motion of the joint afterwards. The wound was closed with sutures with a small rubber-tissue drain, and a dry sterilized gauze dressing applied. Absolute primary union followed. Motion was begun in the joint ten days after operation, especial attention being paid to the voluntary movements. The patient was discharged April 24, with fair motion developing.

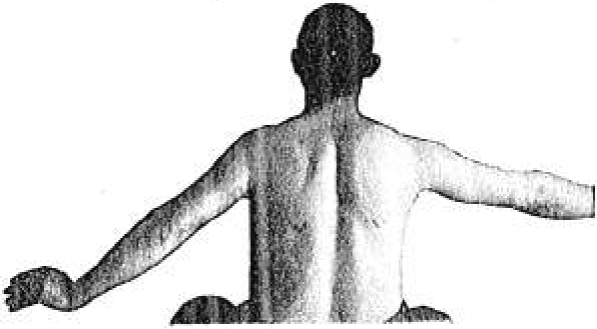

FIG. 2.—Showing amount of abduction. (Angles of scapulæ marked.)

The photographs, taken October, 1899 (Figs. 1, 2, and 3), six months after operation, show the scar and the range of motion of the shoulder-joint proper, the scapula being held stationary. Abduction is about one-half the normal, internal rotation nearly normal, and external rotation is much limited. The shape of the shoulder is good, the deltoid well nourished, and head of the bone is so closely united to the scapula that there is no slipping in any position, and all movements are effected with considerable power. The patient is doing heavy work and the arm is gaining strength. There is some atrophy of the infraspinatus and supraspinatus muscles, which may be due to disuse, as it appears to be diminishing. Neither these muscles nor their nerves were directly involved in the injury to the joint or in the operation.

(D) *Reduction by Open Arthrotomy.*—Free incision upon the displaced bone, and opening the joint for the purpose of reduction is such a modern operation that Poirier and Mauclaire in their essay in 1892 do not even mention it among the methods of treatment. It is an American operation, for as early as 1859, in the first edition of his "System of Surgery" (Vol. ii, p. 194), the great Gross strongly urged immediate arthrotomy in these cases when attempts at reduction otherwise had failed. Nélaton (*Archives générales de médecine*, 1888, p. 450) also suggested it as an adjuvant to the ancient method after the fracture had been consolidated. Stemen (*Journal of the Medical Sciences*, Fort Wayne, Ind., 1893, Vol. xiii, p. 170) appears to have been the first to cut down upon the displaced head in a case of recent injury.

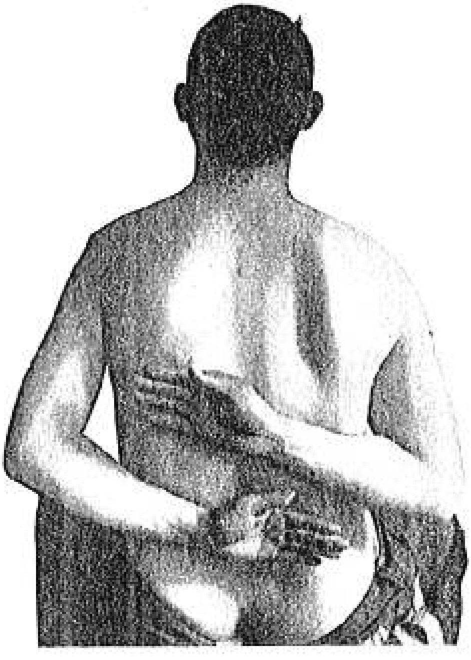

FIG. 3.—Showing facility of internal rotation.

His operation was done in 1870, and he reduced the head, and secured a good result. Porter did a similar operation in the year 1893, and McBurney followed in 1894. The last-named surgeon invented a useful instrument shaped like a "boot-hook," the point of which could be inserted into a hole bored in the upper fragment, while the powerful handle allowed traction and even rotation to be executed easily. In 1895 came my first case. In 1896, Berger, of Paris, and Bull each operated upon a case. Wölfler is reported by MacCormac (French Surgical Congress, 1893, *Transactions*, p. 384) to have operated successfully. Some of the surgeons mentioned have had other cases, and a third has recently come into my hands. Souchon (*loc. cit.*) quotes nine of the above cases, and to his list are to be added two cases by McBurney (Stimson, "Fractures and Dislocations," Philadelphia, 1899, p. 579), one each at the surgical and anatomical neck; a case at the surgical neck by Morton (ANNALS OF SURGERY, 1896, xxiii, p. 756); and my two cases here given,—all successful reductions with good functional results, except Morton's. Morton operated upon a man seventy-four years old immediately after fracture of the surgical neck with dislocation, who died of syncope when first allowed out of bed, eight days after the operation, when the wound was healing well without infection.

The two cases operated upon by me are as follows:

CASE II.—*Fracture of the Humerus at the Surgical Neck with Dislocation; Arthrotomy; Reduction and Wiring of Fragments; Recovery.*—C. G , fourteen years old, school-boy, native of the United States. He fell and injured the left shoulder, and received no proper treatment. When examined, four weeks after the injury, there was no pain, but the motions of the shoulder-joint were greatly limited. The elbow could not be raised from the side, scarcely any rotation was possible, and only slight antero-posterior motions could be made voluntarily. The extent of passive motion was somewhat greater. The deformity of this injury is well shown in the photograph taken before operation. (Fig. 4.)

The head of the humerus was displaced beneath the coracoid process, and there was a fracture of the surgical neck with upward and outward displacement of the lower fragment, and beginning union.

He was admitted to my service at St. Luke's Hospital, and December 4, 1895, under ether anæsthesia, an anterior incision was made over the head of the bone along the border of the deltoid. The line of fracture was transverse, crossing the neck about an inch below the tuberosities. When the head had been somewhat freed, a hole was bored into the upper fragment just below the tuberosities, and McBurney's hook inserted. But when attempts at traction were made, the bone proved to be too soft to hold the hook, giving way around the edges of the drill-hole and allowing the hook to slip out. Very free division was then made of all resisting bands, and with fingers and blunt instruments the head was forced into the glenoid cavity. As the shortening of the arm measured two inches, about one inch had to be removed from the lower fragment before appo-

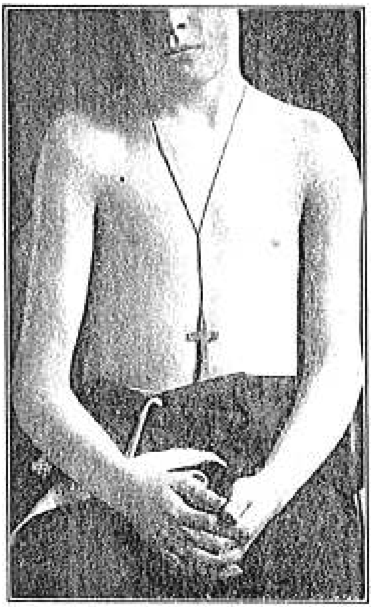

FIG. 4.—Before operation.

sition of the broken ends could be obtained. The head of the bone after reduction remained in a position of inward rotation, on account of adhesions or shortening of the muscles. The lower fragment was therefore rotated inwards as far as possible, and the bone reunited with silver wire. The wound was sutured, and primary union followed, gentle passive motion being begun in ten days, and systematically carried out after the third week.

When shown to the New York Surgical Society (verbal report in ANNALS OF SURGERY, 1896, xxiii, p. 738), three months after the operation, the patient could lift the arm forty-five degrees from the vertical without moving the scapula, and was constantly gaining. Inward rotation was greater than normal, and outward rotation was somewhat limited. It has since been reported to me that he has improved, and that the arm is nearly as good as the other.

CASE III.—*Fracture of the Anatomical Neck of the Humerus; Subglenoid Displacement of the Head; Arthrotomy; Reduction and Pegging of the Fragments; Recovery.*—E. B., eleven years old, schoolgirl, born in England, was admitted to my service at St. Luke's Hospital September 26, 1899. Previous health good. Soon after birth her mother noticed that the left arm was crooked, and the child has never had full use of it. She always held the elbow flexed, and was unable to put the hand over and back of her head except by "throwing" it over. This disability appears to be due to paralysis of some muscles and contraction of others.

The day before admission, while running in the street, she tripped and fell on her left shoulder and her head. She had severe pain in the shoulder and could not raise the arm, but walked home without assistance. Next morning the shoulder was swollen, and a physician made the diagnosis of "posterior dislocation."

September 26, on admission, ether was administered, and the shoulder was examined carefully. The arm could not be adducted and the elbow was held slightly flexed. There was moderate swelling of the shoulder, and a marked projection posteriorly under the acromion near its origin from the spine of the scapula. The head of the humerus was felt in the axilla and did not rotate with the shaft, but crepitus was felt between the fragments on rotation. The small size of the fragment indicated a fracture at the anatomical neck. The posterior projection consisted of the upper end of the shaft of the humerus. Strong extension was made, after gentle attempts had failed, with forcible pressure upon the head of the bone, but it could not be returned to the glenoid cavity. As the parts were not much contused, immediate operation was advised and consented to by the parents.

An anterior incision was made along the border of the deltoid, but it was found impossible to make a free exposure of the head of the bone by this route, and little or no division of the deep parts was made in this line. A posterior incision was then made crossing the base of the acromion, as in Kocher's method for resection of the shoulder, and curving forwards just above, or internal to, the upper border of that process. The base of the acromion was divided and its muscular attachments above severed. The detached acromion was then turned downward and forward in the flap, carrying the deltoid with it, and after some division of the deltoid along its posterior border, and of the subscapularis, a satisfactory view of the glenoid cavity was obtained. It proved unnecessary to divide the capsule of the acromio-clavicular articulation,—as is the rule in Kocher's method. The index finger of the left hand was crowded into the glenoid cavity between the scapula and the upper end of the humerus, while an assistant made strong extension on the arm, and then by very forcible direct pressure upon the head made by the right hand, some fingers being inserted in the anterior wound, and the rest acting in the axilla, the displaced head was with difficulty forced into the glenoid cavity. The line of fracture corresponded exactly with the anatomical neck and the tuberosities were not injured. There was a little tendency for the shaft to ride upward and backward past the head, and a long bone-drill was inserted directly through the outer aspect of the shoulder, grazing the upper end of the lower fragment, and driven deep into the head. By rotating the latter, one could tell when the point of the drill had reached the articular surface, and it was not allowed to penetrate the glenoid. The wound was closed by deep and superficial sutures after the acromion had been united to its base with a silver wire suture, and no drainage was employed. A dry sterilized gauze dressing was applied, over which was placed a spica bandage of plaster-of-Paris, the head of the drill projecting through all the coverings. Extension straps were applied to the arm just above the elbow, and the patient placed on the back in bed with the arm in line with the spine of the scapula, *i.e.*, in full extension, a weight of three pounds acting over a pulley, at the side of the bed, to make traction.

The temperature rose to $101\frac{4}{5}°$ immediately after the operation, but there was very little pain. For the first two days the temperature ranged from 100° to 101°; thence onward, it did not go above 100°.

October 4 (eighth day) the wound was dressed and complete primary union was found. The next day the child was allowed up, the wrist being supported with a sling and the weight hung from a loop of bandage across the bent elbow, the latter hanging by the side. October 16 the drill was removed, and three days later the weight was discontinued. The dressing at this time consisted of a plaster-of-Paris shoulder-cap and spica bandage, and the child was directed to make any movements which this light apparatus would allow. November 8 all bandages were removed and the motions of the shoulder tested appearing to be nearly as good as before the accident. The condition at present (November 16) is as follows: abduction to sixty degrees (over half of the normal); adduction complete; internal rotation almost normal; external rotation much limited; antero-posterior movements free. In all of these the scapula is held in the normal position of rest. The child can "throw" her arm over and behind her head, and otherwise use it just as she used to do, and can also pass it behind the back. There is no atrophy of the deltoid.

Comparison of Reduction and Resection.—In order to obtain an idea of the relative merits of these two procedures, reduction and resection, we must first remember that even the best functional result after resection, of which the first case reported herewith may be taken as an example, is not to be compared to the nearly perfect shoulder-joint which can sometimes be obtained by returning the normal head to its natural articulating cavity. The result of a reduction may fall considerably below this perfection and yet be as good as the best obtainable by resection. We shall therefore classify the results of reduction as good, fair, and bad, and the results of resection as fair, improved, and bad. It should be added that even the poorest functional result found in the cases so far reported is a great improvement upon the condition of an arm left without operation.

RESULTS OF OPERATION.

Fracture of Surgical Neck.	Good.	Fair.	Improved.	Bad.	Died.
Reduction............	Stemen I.	Berger	....	Porter II. (resected.)	Morton II.
"	Stemen II.	....	....	....	....
"	Porter I.	....	....	....	....
"	McBurney I.	....	....	....	....
"	McBurney III.	....	....	....	....
"	Curtis II.	....	....	....	....
Total	6	1		1	1
Resection	....	Tripier	Porter II.	....	....
Total	....	1	1	1	....
Anatomical Neck.					
Reduction............	McBurney II.	Bull	....	....	....
"	McBurney IV.	Wölfler	....	....	....
"	Curtis III.[1]	....	....	....	....
Total	3	2	....	....	....
Resection[1]...........	....	Mauclaire II.	Croft	....	Morton I.
"	....	Clutton	Brinton	....	Monks
"	....	McGraw	....	....	Gerster
"	....	Curtis I.	....	....	....
Total	....	4	2	....	3
Total, 25 cases...	9	8	3	1	4

Theoretically, we would assume that in fracture of the anatomical neck resection would be the better operation, for reduction might result in union with slight displacement of the small fragment, or adhesions might form because of the small blood supply of the head, or the callus might encroach upon the articulating surfaces, and the motions of the joint might be impaired by any of these causes. On the other hand, we would suppose that in fracture limited to the surgical neck reduction would give an excellent result, as the line of the fracture is far removed from the joint, and the latter might not even be exposed during the operation; while resection would remove so large a portion of the bone as to tend to the production of a flail-like articulation. Let us see how these ideas are borne out in practice.

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[1] Mauclaire I. also belongs here, but no details of result are given.

We have in our list only two cases of resection after fracture of the surgical neck, one with a fair functional result, the other improved, and the data are insufficient to determine the question. The results of reduction for this inquiry are six good, one fair, and one bad,—the last being Porter's second case in which infection took place with necrosis and subsequent resection.

After fracture of the anatomical neck treated by reduction there are three good results and two fair, to set against four fair results and two cases improved after treatment by resection. The results of reduction for this injury, then, are far better than we would theoretically suppose.

In all we have twenty-five operations, with nine good and eight fair functional results; three cases improved and one bad result. The four remaining cases terminated fatally. Porter's second case counts twice, as a bad result after reduction, and improved by resection. To obtain such good results after an injury which without operation generally greatly impairs, if it does not destroy, the usefulness of the limb, would warrant quite a high mortality; but when the four fatal cases are studied it will be seen that the death was not always due to the operation. Monks's case died four days after a resection carried out on the day following the injury, with symptoms of some abdominal condition, probably a simultaneous internal traumatism received. The wound was seen to be healing well. Morton's second case occurred in a man seventy-four years of age, who died on the eighth day after successful reduction, when the wound had practically healed, syncope coming on when he was first allowed to sit up out of bed, and the death may be charged to some heart-lesion or old age. In Gerster's case "the patient reacted poorly from the operation, the wound suppurated," and we cannot say that the result was not due to septic infection of the wound. Morton's first case died three weeks after the operation, with symptoms indicating pyæmia secondary to the suppurating wound of operation. Only two deaths are therefore due to the operation,—less than ten per cent. mortality,—and it is clear that the danger of operating upon these cases has been exaggerated.

As the principal danger appears to lie in infection of the wound, it becomes interesting to study the course of these wounds. In twenty-two cases (counting Porter's second case twice) the course of wound-healing is known, primary union having been obtained in fourteen cases, suppuration occurring in eight, and terminating fatally in two of these. As to the effect upon the functional result, suppuration occurred only once in the seven cases which yielded finally a good result, twice in the seven cases with fair result, and twice in the three cases which were merely improved, while in the only case with a bad result it caused necrosis of the head. This is as was to be expected, for suppuration would certainly tend to impair the ultimate result, even if it did not produce serious consequences otherwise.

Resection is always an easier operation than reduction under similar circumstances, and leaves a wound which is a simpler cavity, free from loose bone liable to necrosis. The danger of shock, severe loss of blood, and wound infection would be naturally greater with open reduction, but our cases hardly confirm the importance of these dangers. Of eleven cases of reduction there was suppuration in only three cases, with one good functional result, one fair, and one bad. Of ten cases of resection suppuration occurred in four, with one fair result, one case improved, and two deaths. Porter's second case is omitted from the resected cases because suppuration was present already when the resection was done, but is included in the reductions as a bad result. These figures, however, are so small that they do not overthrow the theoretical advantages of resection in regard to wound-healing, as accidental circumstances might easily control the results in such a small series of cases.

Technique.—In these operations, the incision parallel to the anterior border of the deltoid muscle is the best for all anterior displacements of the head, and generally lies directly over that part. When the head is in the axilla, an incision in that region directly over the head allows of easy access to the upper fragment, but affords no facilities for its reduction. Accordingly, we find that the axillary incision was employed only once in the three cases of subglenoid dislocation in which the head was reduced, while it was used in all the eight cases treated by resection.

The choice of incision in these subglenoid displacements is quite important, and the fact that in most of these cases the axillary incision was employed may explain why the head was removed in eight out of eleven cases, all with fracture of the anatomical neck. Wölfler alone succeeded in reducing the head through this incision. Bull and McBurney succeeded in reducing the head through anterior incisions along the deltoid. In my case the anterior incision was tried and found useless, and a posterior one was added. The posterior-superior incision seems to me the most suitable for this class of cases. Whether we employ Kocher's method, as in my case, or some other, will allow of further study. Severeano, of Bucharest, recommended at the French Surgical Congress of 1893 a method for opening the shoulder-joint which might be found useful.

He makes an incision across the top of the shoulder a little inside of and above the acromion and parallel to it, dissects up the skin until the bone is uncovered, and then saws the acromion longitudinally, so as to detach its external border with the attachments of the deltoid. Another incision is carried vertically downward from the posterior end of the first, and if necessary a similar incision can be added at the anterior end along the anterior border of the deltoid. These two incisions (or three) form a flap with the border of the acromion in its upper edge, and its substance made up of the deltoid muscle and skin. On turning this flap down good access to the joint is obtained, the subscapularis tendon only needing partial division. The deltoid attachments are perfectly restored by suturing the portion of the acromion in the flap to the remainder of that process. The method is more complicated than Kocher's, but would seem to afford greater security of bony union of the acromion.

A posterior displacement of the head would require a posterior incision with or without division of the acromion.

McBurney's hook will often be found of service, but, as in Bull's case and mine, it may tear out of soft bone. Generally, the fingers and blunt instruments used as levers will suffice to return the head of the bone to its place, but in some cases extensive division of bands, capsule, etc., and the employment of considerable force will be necessary. As we are speaking only of recent cases (within the first month), the glenoid cavity will not be filled up with fibrin and connective tissue, a complication which renders later operations very difficult.

After reduction of the upper fragment, some surgeons have used wire, some catgut, and some pins to hold the bones in place. The wire sutures appear to me best for the lower fractures, and the pin for those of the anatomical neck. If there was no tendency to displacement it would probably be safe to rely upon the ordinary dressings to keep the bones in position without suturing or pegging. If the surgeon is not absolutely sure of his asepsis a small drain is advisable, but it may be repeated here that the great danger of the operation is infection, and the surgeon who is not sure of his asepsis should not operate upon such cases.

In all the cases here mentioned the operation was performed at some time in the first month (first day, three cases; second day, two cases; third day, two cases; eighth to fourteenth day, four cases; fifteenth to thirtieth day, seven cases), and the immediate healing of the wound or the functional result does not appear to have been in the least influenced by this factor. Of seven cases operated on in the first three days there was suppuration (slight) in only two. Some surgeons have claimed that the immediate operation is more dangerous on account of the effused blood and contused tissues, and therefore greater liability to infection, but these figures do not bear out this theory. Where the damage to tissues is very great, however, it would be undoubtedly wiser to defer the operation, and also in cases accompanied with considerable shock from the accident or exhaustion from pain. There is usually little risk from this short delay. Of six cases operated on in twentyone to thirty days the functional result was good in two, which were reduced, fair in two resected, while suppuration occurred in the other two, causing necrosis in one and in one death.

It is very important to begin passive motion of the joint at the earliest possible moment, and in my cases it was begun ten to fourteen days after the operation. In cases of resection the patient can be allowed to move the arm as freely as he will after the wound has healed. In the reduced cases the first motions should be made by the surgeon on the same principles as in simple fractures near joints, and voluntary motion not allowed until consolidation is well advanced. In fracture of the anatomical neck voluntary motion such as can be made under a shoulder-cap and with the arm in an ordinary sling can be allowed after the third week, but in fracture of the surgical neck it is well to postpone it until five weeks have elapsed. But even in the latter cases passive motion after the third week can be made as freely as may be done without pain. The importance of early motion is to be emphasized, for it not only prevents adhesions but avoids atrophy of the muscles. This muscular atrophy is inevitable, and its occurrence partly explains the fact that good functional results are so much more difficult to obtain in cases operated upon more than a month after the receipt of the injury.

CONCLUSIONS.

(1) In fracture of the upper end of the humerus with displacement of the upper fragment from the glenoid cavity, when proper attempts at simple reduction under general anæsthesia have failed, operative measures should be resorted to unless shock, other injuries, or extensive damage to the soft parts about the shoulder justify delay. A delay of from one to four weeks will not impair the result.

(2) Anterior displacements require an anterior incision, subglenoid or posterior displacements require a posterior incision, preferably by Kocher's method.

(3) The head should be restored to its place, if possible, and resection resorted to only when reduction is impossible or would require such extensive damage to the parts, or such pro-

longation of the operation, as to increase the dangers of wound infection or of shock.

(4) Resection will probably give a better result in fracture of the anatomical neck than in that of the surgical, but reduction is to be preferred in both cases.

(5) Asepsis is an indispensable requirement for a good functional result, and these operations must not be undertaken except under aseptic conditions.

(6) Motion should be begun in the joint as soon as the wound has healed, in ten to fourteen days after the operation.